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SUBJECT Comments and Evaluations on Twenty-two Articles on Metal Treating, Welding, Examination, etc. Appearing in USSR Magazine

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X 1. Ye O Paton: Progress in the Development of Automatic Submerged-Arc Welding in the Last Two to Three Years. Avtogennoye Delo (1950) no. 11, pp3/8

a. A summary covering briefly the marked increase in commercial use of this welding method, and research and development projects carried out since 1947. Of metallurgical interest:

1. Since this type of welding makes it possible to weld structures such as bridges and ships, which were formerly not welded, it has been realized that all low-carbon steel is not satisfactory for this purpose. In particular, it has been determined that rimmed steel has inadequate ductility and that it is necessary to use killed steel. A suitable specification has been worked out with the result that already in 1950, 2,500 (metric) tons of bridge construction have been welded.

2. During this period special fluxes have been developed for alloy and medium-carbon steels. Particular attention has been paid to the problem of intergranular corrosion of austenitic steel (both solid and clad); the best results have been obtained with the addition of columbium to the weld deposit.

3. Some trouble has been encountered with excessive reduction of phosphorus from the ferromanganese in the flux, so the weld deposit has higher phosphorus contents than permitted by the specifications.

b. The problem of inadequate toughness and ductility of structural carbon steel is reminiscent of trouble with welded ships in the US during the war. The types of tests used and the general approach appear to be similar to those used here. It is not clear, however, whether there were significant failures in the USSR that led to this concern with toughness, or whether the possible danger was pointed out merely on the basis of theory and laboratory work.

Rather interesting speculations might be based on the final conclusion that killed steel must be used in view of the emphasis placed on welding for this type of application. It is well known that the yield of finished product is less for killed than for rimmed steel. Also, steel plants must have special equipment for hot topping to produce killed steel. These facts were brought out in the US during the discussion of the possibility of specifying killed steel only for ships; it was then stated that there was not sufficient hot-topping capacity to produce all ship plate from killed steel. There is no indication that this factor was taken into consideration in the USSR. It is, however, mentioned that the ministry for the metallurgical industry at first scoffed at the idea that special steel should be used and insisted it was up to the welding industry to devise methods that would be satisfactory for any steel. Naturally, there is one significant difference in that service temperatures might be appreciably lower in parts of the USSR in winter than those that would be normally encountered with ships. The laboratory work, however, appears to have been based on a temperature of -40 F, which is similar to that used in some of the laboratory work in the US.

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c. Mention is made of the need for further cooperation in connection with the development of weldable high-strength low-alloy steels, which are said to be used to an increasing extent. One of the serious deficiencies of these steels is stated to be their low toughness and high notch sensitivity. This type of steel is also widely used in the US , but the factor of good weldability has generally been one of the prerequisites in selection of suitable compositions.

d. Austenitic chromium-nickel steel is said to be used widely in industry, both solid and clad. This would also be true in the US . Likewise, it has generally been held here that weld deposits of these steels must contain a certain amount of columbium if the steel is to be used under conditions that might cause intergranular corrosion. The exception, not mentioned in the present paper, would be the "ELC" grades with a guaranteed maximum carbon of 0.03%. Presumably these extra-low-carbon types were not being made in the USSR in 1950, although they were then available in the US .

e. The paper has not been accurately proof-read. There is, for example, a typographical error of -300° for -30°.

2. P S Koltunov: Standard for Checking the Sensitivity of Radiography and Evaluation of Defects in Metals by Gamma-Radiographs. Avtogennoye Delo (1953) no. 6, pp 23/24

a. A routine, practical paper.

b. Of interest is the fact that the only source of gamma rays given in the paper is radium capsules. Radon is not mentioned, nor are the various radioactive isotopes, such as cobalt 60. The latter have become reasonably readily available in the US as the result of our atomic-energy program and are now being used to a significant extent here for inspection of metals.

3. A M Makara and [illegible] S Kasatkin: On the Usefulness of Bend Tests for Welds. Avtogennoye Delo (19[illegible]) no. [illegible], pp 6/13

a. During 1948/1949 failure of automatic welds to meet standard free-bend tests on butt joints led to rejections at various machinery plants. The Institute of Electric Welding therefore made an extensive study of this test. (Apparently work was done only on carbon steels.) It was concluded:

(1) Free-bend tests on butt joints do not "characterize the toughness of the weld" as stated in the specification. This test is not only uninformative but may cause rejection of satisfactory welds.

(2) Notched and unnotched longitudinal-bead-weld bend tests are proposed. They are said to be just as easy to make and just as sensitive to small macrodefects as the free-bend tests on butt joints, but far more satisfactory as an indication of the quality of welds.

(3) Until the new type tests are accepted, the results of free-bend tests on butt joints should be evaluated only in conjunction with the results of other tests and a careful study of the bend-test fractures. No rejections should be made if the elongation in the free-bend test is over 40%.

b. The results are in general agreement with US work.

(1) Unnotched butt-weld bend tests have been included in US standards since 1920. The general consensus has been that these tests are relatively sensitive to changes in soundness, joint design and restraint, and welding procedure, but relatively insensitive to composition, mode of deoxidation, thermal and mechanical history of the base metal. As stated by Stout and Doty "...(such tests) are insufficiently sensitive to changes in the factors that affect weldability, especially for the low-carbon structural steels."
R D Stout and W D'O Doty: Weldability of Steels. Welding Research Council (1953) 381 pp

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(2) Unnotched bead-weld bend tests fall in the same general category as unnotched butt-weld bend tests, but a number of notch-bend tests have been found to be more sensitive to factors affecting weldability. Some of the latter are similar to that proposed by Makara and Kasatkin.

X 4. K K Khrenov and M M Bort: Weld-Metal Strength of Gas Welds in Low-Carbon Steel. Avtogennoye Delo (1953) no. 6, pp 1/5

a. This paper is mainly a criticism, with suggestions for changes, of certain parts of the standard qualification rules for welders. Most of the paper deals with carbon steel but the following points may be noteworthy:

(1) Gas welding has not progressed for the past 40 years. Under present conditions the same properties can not be obtained from gas welds as from high-quality arc or submerged-arc welds.

(2) A systematic study of possible improvements in gas welds should be made.

(a) One method would be the use of alloy-steel rods. Manganese would be the principal element considered as an alloying element, but small amounts of other elements such as chromium and nickel might also be included.

Sometimes, however, an increase in the carbon content and the presence of alloying elements increase the porosity of the weld metal as well as its strength. For example, special rods of the same composition as 30 KhMA and 30 KhGSA are available but the tendency is to use unalloyed low-carbon rods for gas welding these grades. To obtain the same composition and strength in the weld metal as in the parent metal, the contents of carbon and alloying elements in the rod must be 60/70% higher than in the parent metal; this may complicate the welding process.

(b) The other method would be the use of fluxes, which are believed to be desirable and necessary for gas welding of low-carbon steel, although they are not being used in the USSR. It should be possible to develop fluxes that would not only serve the usual purpose of removing oxide from the surface, but would also aid in refining and deoxidizing the molten metal in addition to adding alloying elements to the weld metal. It would be advantageous if the flux served to decrease the sulfur content of the weld metal. Preliminary work on the use of fluxes for gas-welding low-carbon steel has been promising.

b. It is well known that certain changes in the composition of the rod take place during welding. The statement that the carbon and alloy contents must be 60/70% higher in the rod is questionable. The third edition of the Welding Handbook gives the following recovery values for the elements in 30 KhMA and 30 KhGSA:

	per cent recovery when melted under neutral flame and when appreciable amounts of deoxidizers are present
carbon (up to 0.20%)	100
manganese	65
silicon	50
chromium	80/85
molybdenum	100

X c. In the US , as has apparently been the case in the USSR, fluxes are not generally used in gas welding low-carbon steel. On the other hand, the use of alloy-steel rods for gas welding is fairly common in the USA. A 1950 pamphlet of Air Reduction X Co. on Gas Welding Supplies lists five low-alloy steel rods, and one unalloyed mild-steel rod. Vanadium and molybdenum are used for alloying purposes as well as the alloys mentioned by Khrenov and Bort.

d. Despite the availability of low-alloy steel rods, however, unalloyed low-carbon rods have often been used for low-alloy steel sheet. For example, in gas welding normalized or annealed AISI-SAE 4130 sheet and tubing, better results have frequently been obtained with such rods than with rods similar in composition to the parent metal. This is in agreement with Soviet practice (as described by Khrenov and Bort) on 30 KhMA (which is similar in composition to AISI-SAE 4130) and 30 KhGSA. More recently the emphasis in the US has been on the use of higher strengths, which involve heat treatment before or after welding; in these cases, alloy-steel rods have generally been found necessary, although the composition does not always match that of the parent metal. Presumably this would also be true in the USSR if and when higher strength steels were used.

e. The listing of the chromium-molybdenum 30 KhMA as well as the chromium-manganese-silicon 30 KhGSA would indicate that some molybdenum is being used in the USSR for low-alloy steels, perhaps for structural aircraft parts. (The "A" indicates a special quality steel.)

5. S V Vershinskiy: Impact Strength of Welded Joints of Open Hearth and Bessemer Steel for Construction of Railroad Cars. Avtogennoye Delo (1953) no. 6, pp 5/10

a. The suggestion was made that Bessemer steel could be used for shapes in construction of railroad cars. Since these cars operate for a considerable portion of the year at low temperatures, and since impact is involved, comparative impact tests at low temperatures (5° to -41° F) seemed of most significance. Tests were made on large sections (some full-size beams; others short sections of I-beams) as it was known that tests on small specimens would not be conclusive. The results showed that Bessemer steel could not be recommended for load-carrying elements of railroad cars because of its brittleness at low temperatures, and notch sensitivity.

b. The general test procedure appears fully satisfactory, particularly the use of large sections and low temperatures. No specific analysis is given of the material tested, nor is any indication given of the method of deoxidizing the Bessemer steel. The latter would be most significant in the present case.

The results are in accordance with general experience on ordinary Bessemer steel, although fully deoxidized Bessemer steel has been stated by Parker to be equal to basic-open-hearth steel in resistance to shock and vibration even at low temperatures. Nevertheless, the production of Bessemer steel in the US is under 5% of the total ingot tonnage, and much of this is used for bar parts where machinability is the decisive factor.

C M Parker The Metallurgy of Quality Steels. New York (1946) p 16

In Europe a much larger percentage of the total steel production is made by the converter process. Thomas or basic-Bessemer steel comprises about 40% of the German production, about 60% of the French production, and 85% of the Belgian production. Special melting practices have been and are being developed to make low-nitrogen low-phosphorus steels that are supposed to have properties comparable with those of basic-open-hearth steel.

d. Perhaps the incentive to test the Bessemer steel came from the fact that less capital is required for Bessemer plants. The yield of useable product, however, is generally less for Bessemer plants than for basic-open-hearth melting.

6. A M Glikshtern: Structure and Hardness of Hardened Case of Steel, Flame Hardened with an Oxygen-Petroleum Flame. Avtogennoye Delo (1953) no. 6, pp 10/12

a. An oxygen-petroleum flame is highly satisfactory for surface hardening unalloyed medium-carbon steel to case depths as high as 0.3 in. This maximum case depth is about two and a half to three times as great as can be obtained with an oxyacetylene flame without overheating the surface of the steel.

b. It is not clear just what specific product is meant by 'petroleum'.

c. Deeper flame-hardened cases may be obtained with oxyacetylene than Glikshtern indicates. For example, Inskeep shows as typical the hardness gradient of a 0.25-in. deep case obtained on a medium-carbon steel similar to that used by Glikshtern. Howat has indicated that where extra depths are required - for instance, over about 0.2 in. - the distance between the work being heated and the heating tip is increased to allow time for deeper penetration of the heat without overheating the surface metal.

J J Howat: Versatility of Oxyacetylene Flame-hardening. Steel 125 (1949) no. 6, pp 64/67, 94

H V Inskeep: Flame-Hardening - A Flexible Method of Surface Treatment. Machinery 58 (1952) no. 1, pp 160/171

d. Oxyacetylene is by far the most popular fuel for flame hardening in the US, but other fuels have proved satisfactory in some cases provided the equipment was suitably modified.

e. This paper is accompanied by a rather sharp statement by the editors, who point out that the tests were quite limited and did not take into consideration certain basic factors, such as distance between the work being heated and the heating tip. This criticism is, of course, quite justified but it does not explain why the paper was published in the first place.

7. L Ye Fedotov: Welding Chromium Steels. Avtogennoye Delo (1955) no. 6, pp 20/21

a. A review, based on Soviet literature, of welding procedures for straight chromium steels with 4/30% Cr. Most attention is given to arc welding.

b. The recommendations in this brief review are highly conventional. Of interest in respect to materials:

(1) The 4/6% Cr steels are made with and without an addition of molybdenum to decrease temper brittleness and improve creep properties. Although the standard AISI compositions (types 501 and 502) do not specify molybdenum, little if any of this type of material is being made in the US without molybdenum. No mention is made of other modifications with silicon, aluminum, columbium, or titanium, which have found limited use in the US, but the analysis of one electrode shows a high silicon content (1.7%).

(2) No mention is made of alloys in the intermediate range of 6/12% Cr. In the US there is a fairly sizeable production of chromium-molybdenum steels with 7 and 9% Cr. These steels are used mainly in the petroleum industry where better corrosion or oxidation resistance is desired than would be obtained with lower chromium contents.

(3) In the discussion of the grades with 12/16% Cr, no mention is made of the low hardenability types, such as type 405. In the US this type is sometimes used for applications such as vessel liners where considerable welding is involved.

(4) Under the 16/18% Cr heading, no mention is made of the use of titanium. In the US there has been a limited production of type 430 (17% Cr) with titanium, which is claimed to improve the properties after welding.

(5) The review of the 20/30% Cr steels mentions various elements that may be used to improve grain structure and properties but states that current practice in the USSR is based on the simultaneous addition of titanium and aluminum. In the US the most common addition for this purpose is nitrogen. Although the action of nitrogen in these steels differs from that of titanium and aluminum, the net result would probably be comparable.

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8. K A Udotov: High-Productivity Methods of Welding Developed by TsNIITMASh MTM. Avtogennoye Delo (1950) no. 11, pp 8/14

a. A summary of research and development projects at TsNIITMASh MTM. Much of the material was also included in Paton's review and has been discussed there. Additional items of metallurgical interest:

(1) Special fluxes have had to be developed for submerged-arc welding of stainless steel. To obtain weld deposits resistant to intregranular corrosion, the electrode must contain either about 2% Cb or 2% Ti.

(2) A number of new electrodes has been developed.

Ye O Paton: Progress in the Development of Automatic Submerged-Arc Welding in the Last Two to Three Years. Avtogennoye Delo (1950) no. 11, pp 3/8

b. Item A1 appears to be in conflict with Paton's report, which was [illegible]ed on independent work at the Institute of Electric Welding as well as at the TsNIITMASh MTM.

(1) Paton's report is more in line with practice elsewhere, where it has generally been considered necessary to use columbium-alloyed electrodes for welding austenitic stainless steels when weld deposits resistant to intergranular corrosion are required. This has been the case even where titanium has been used to stabilize the parent metal. There have been a few indications that titanium [illegible] could be used in the electrode under certain conditions, but as far as is known such electrodes have not been used commercially in the US.

(2) Again no mention is made of the "extra-low-carbon" grades, which would avoid or minimize the use of columbium or titanium.

(3) Incorporation of either 2% Cb or 2% Ti in the electrode would almost certainly introduce difficulties in fabrication of the rod.

c. In most cases insufficient information is given on the new electrodes to permit comment.

(1) TsL-6, however, is similar to the "0.5% Mo" electrode widely used in the US, mainly for the same purpose of improving strength at temperatures up to about 950°F.

(2) TsL-14 is said to be similar to TsL-6, but with 0.35/0.55% Cr to hinder graphitization. As mentioned in the review of Oding, the Soviets appear to have encountered graphitization similar to that observed in the US. The addition of about 0.5% Cr would give a material similar to grade A of ASTM A 301-52aT. This material was originally introduced as a graphitization-resistant substitute for the 0.5% Mo grade. More recently, however, preference seems to have been given to grade B of ASTM A 301-52aT with about 1% Cr and 0.5% Mo as a steel with more resistance to graphitization.

(3) TsL-12 and TsL-13 have been developed for welding EI 454, which is said to be used for boilers at temperatures up to about 1065°F. The TsL-12 uses a low-carbon rod and adds the alloys through the coating, while the TsL-13 uses a rod of composition similar to EI 454. This grade was discussed previously under Oding, item C7.

I A Oding: Basis of the Strength of Metals in Steam Boilers, Turbines and Turbine Generators. Moscow 1949. 560 pp

9. K K Khrenov and D M Kushnerev: Automatic Arc Welding under a Double Flux. Avtogennoye Delo (1950) no. 5, pp 3/6

a. Description of a new method of submerged-arc welding, predicated on the idea that the main function of the welding composition (flux) is to exert pressure on the molten metal during welding.

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(1) Very little of the flux participates in the welding reaction. This small amount of "active" flux is backed up by a large amount of "passive" flux.

(2) If two different fluxes are used, one active and one passive, it is possible to use as active fluxes, materials that would not be satisfactory for the conventional type of submerged-arc welding. For example, it is much easier to incorporate ferroalloys, so alloying elements can be introduced from the flux rather than from the electrode. As a matter of fact, compositions similar to normal electrode coatings may be used for the active flux. This flux is not fused prior to use but is prepared by mixing the solid ingredients with a fluid, such as water glass, and briquetting.

(3) Various materials could be used as the passive flux, but the most suitable proved to be fused active flux, which had been properly pulverized after removal from completed welds.

b. Except for novelty, the virtues of the proposed method are not cl[illegible].

(1) Means for preparing and handling two fluxes must be provided.

(2) The welder must decide how much active flux is needed.

(3) The welds look no better than those that can be made with the conventional submerged-arc process.

(4) Furthermore, it is possible to include alloying elements in the flux with the present submerged-arc process. This is being done in various cases in the US .

c. In a footnote, the editors cast well-justified doubt on the proposed theory as to the major function of the flux.

d. Many of the tests were made on SKhL-1, which is similar to Cor-Ten, one of the high strength low-alloy grades widely used in the US .

	%C	%Mn	%P	%S	%Si	%Cu	%Cr	%Ni
SKhL-1	0.16	0.60	0.020	0.020	0.54	0.34	0.74	0.53
Cor-Ten								
range	0.12 max	0.20/0.50	0.07/0.15	0.05 max	0.25/0.75	0.25/0.55	0.30/1.25	0.65 max
typical	0.09	0.38	0.09	0.033	0.48	0.41	0.84	0.28

The main difference is the lower phosphorus content in SKhL-1; it is possible that this is a deliberate attempt to improve low-temperature impact for parts operating at very low winter temperatures.

According to the 1952 United States Steel catalogue on this grade, it is readily welded by the submerged-arc method. No special restrictions are involved, and the electrode material used for the welding of structural carbon steel is recommended. The alloying elements necessary for strengthening the weld will be obtained by dilution with the parent metal.

The mechanical properties given for SKhL-1 are similar to those published for Cor-Ten.

Since World War II there has been considerable emphasis in the USSR on the advantages of high-strength low-alloy steels, but this is one of the first papers reviewed that gives an actual composition. At times it has been hinted that one of the Soviet projects was to develop grades of this type that could be produced from naturally alloyed iron ore. It is not known whether SKhL-1 is considered to be one of these grades.

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10. P N Berezkin: On the Weldability of Rimmed Steel. Avtogennoye Delo (1950) no. 5, pp 21/22

a. In recent years there has been an increasing use of rimmed steel, particularly for parts requiring deep drawing, but difficulties have been encountered with weldability. Cracking and other defects found on welding tractor exhaust muffles of rimmed steel are attributed to nonuniformity of composition and excessive nonmetallic inclusions. It is concluded that rimmed-steel sheet should not be used for welded parts that must be gas- or water-tight, or that will be subject to impact or alternating stresses in service.

b. Rimmed and semi-killed steels are widely used in the US and are generally considered to weld easily without cracking in the weld or adjacent zones. A considerable tonnage of pipe, for example, is welded from such steels. ASTM A 53-52T covering Welded and Seamless Steel Pipe makes no restrictions in this respect for open-hearth steel but does state that steel for grade B bessemer pipe shall be killed. The main welding procedure, where difficulty has been experienced with rimmed steel, is submerged-arc welding where killed steel is sometimes preferred. In this case the trouble has been attributed to sulfur inclusions between the skin and core of the rimmed steel.

c. From the brief description, it might be surmised that the trouble encountered in the USSR is at least partly the result of higher sulfur contents and greater amounts of inclusions than would normally be expected in the US. This may indicate that some of this Soviet steel is being produced by a converter process rather than in the open hearth. Berezkin does not specifically cover submerged-arc welding; in fact, his second example refers to gas welding. There is no mention of any attempt to overcome the poor weldability by changes in prior condition of the steel, type of electrode, or welding procedure.

11. V G Vagner and O G Vagner: Electric Welding of I-Beams. Avtogennoye Delo (1950) no. 5, pp 22/24

a. One of the leading questions in the use of welded structures is the dynamic strength of welded parts. The susceptibility to cracking of welded joints during the welding process is the main difficulty. Ye O Paton's conclusion as to the necessity of using killed steel with present welding procedures is logical and is beginning to be followed, but many factories still have to weld rimmed steel. The present paper is intended as a guide in the welding of rimmed steel.

(1) It is impossible to eliminate all cracks in welded structures of rimmed steel. A major factor is the great variation in segregation, sometimes even within a single sheet.

(2) At present rimmed steel should be welded only under constant supervision, and preferably in the shop and not in the field.

(3) A series of tests is proposed for rimmed steel to be used for welding.

(4) The output of standard killed steel must be increased, since only with its use can more extensive use of electric welding for critical parts of structures be possible.

b. Three papers from about this period (the present paper, Berezkin, and Paton) all point to difficulty in welding rimmed steel. There is some question, however, as to whether the basic trouble is in the actual welding process (as would be indicated by Berezkin and the present authors), or whether it is in the inadequate toughness and ductility of the completed weldments (as indicated by Paton). As mentioned in the discussions of the other two papers, the former problem is not serious in the US, but the latter has received much attention.

P N Berezkin: On the Weldability of Rimmed Steel. Avtogennoye Delo (1950) no. 5, pp 21/22
Ye O Paton: Progress in the Development of Automatic Submerged-Arc Welding in the Last Two to Three Years. Avtogennoye Delo (1950) no. 11, pp 3/8

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c. Certainly the tests advocated for rimmed steel to be welded would be extremely costly. For example, the idea of making a sulfur print on each sheet, which is just one of the proposed tests, would be time consuming as well as expensive.

d. As discussed under Paton, the proposal to use only killed steels for such welded parts leads to conjectures about the resultant decreased output of steel. Also, unless a good deep-drawing quality of killed steel has been developed (and it took some time to do this in the US), it is possible that difficulties in fabricating some of the deep-drawn and formed parts prior to welding might occur if only killed steel were used.

12. V P Smirnov: Electrospark Strengthening of Cutting Tools. Avtomobil'naya i Traktornaya Promyshlennost' (1950) no. 12, pp 17-20

a. For continued effectiveness, surface treatments applied to cutting tools during fabrication must be renewed after each sharpening. It is both costly and time-consuming to renew chromium plating or cyaniding. A new method has been developed by V R and N I Lazarenko to answer the need for a simple means of treating tools after grinding. When an electric spark is drawn between a carbon-graphite or hard-metal (sintered-carbide) electrode and a tool, some particles of the electrode are deposited on the tool, which is also slightly pitted by the arc. The life of the tool is increased if the parts subject to wear are so treated.

1. Apparently the process can be used only on high-speed-steel tools.

2. Most of the work seems to have been done with the carbon-graphite electrode.

3. Increases in life for various types of tools vary from "up to 20%" to "up to 60%".

4. In the case of chromium-plated or cyanided tools, the electrospark strengthening is applied only where the previous coating has been ground off.

5. The Stalin automobile plant at Gorki has saved 718,000 rubles a year by the use of this treatment.

b. It is not known whether a similar process has been used here as there are various proprietary surfacing methods, details of which have not been disclosed. It is quite possible, however, that the carbon particles deposited on the slightly pitted surface would prove to be a better lubricating medium than externally applied lubrication and thus would increase life.

c. There is some reason to be skeptical of the economic value of the process.

1. Variations of 20% in life occur with closely controlled laboratory cutting tests; even greater variations are encountered in plants. Therefore, increases in life of "up to 20%" are not very convincing.

2. It is doubtful whether the necessary equipment would be much cheaper than either chromium plating or cyaniding. Moreover, fewer man-hours would be needed for either of these methods than for the new method, where the electrode must be guided by hand along the surface to be treated until the slender electrode has contacted all parts. Unless the work is carefully done, there is the added hazard that part of the surface may remain untreated. This suspicion is borne out by the list of causes for inadequate results.

d. From the discussion it would sound as if practically all high-speed-steel tools were chromium plated or cyanided. Although both methods are used in the US , probably the majority of high-speed-steel tools is not so treated. As a rule, no attempt is made to renew the coating after sharpening.

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c. Smirnov speaks of high speed steel as RF1 (the 18-4-1 type) or its substitutes. This would tend to indicate that at least some of the old standard 18% W steel is still being used despite the large amount of work carried out in the USSR on the development of lower alloy high speed steels.

13. D I Romanov: On the Theory and Practice of Induction Heating Metals for Forging and Pressing. Avtomobil'naya i traktornaya Promyshlennost' (1950) no. 12, pp 28,30

a. A critical review of (Soviet) literature with special reference to incorrect cost comparisons of induction and furnace heating. Romanov concludes that the question of suitable heating methods needs further consideration and that more attention should be paid to the quality of publications.

b. There has also been some use in the US of induction heating for forging or other hot-working operations, but a completely accurate comparison of the cost of such heating methods as compared to furnace heating is not simple. Some of the factors that have been given much weight in the US in cases where induction heating has been selected - for example, less space required, lower loss of metal due to scaling, less die wear because of better surface of heated metal - apparently play a minor role in the USSR where major emphasis is placed on production rate, capital expenditure and operating cost.

14. I M Vasin and A N Malikov: Forming Hollow Parts with Metallic Formblocks and Rubber. Avtomobil'naya i traktornaya Promyshlennost' (1950) no. 12, pp 25/27

a. For more than 12 years, duraluminum parts have been formed in hydraulic presses with soft or nonmetallic formblocks and rubber platens. The process has now been modified by the introduction of a table that fits inside the container at the end of the stroke. This serves to avoid wrinkling and to keep the rubber confined in its container. The combination of this modification and more powerful presses makes it possible to form harder and thicker sheet - for example, stainless-steel exhaust manifolds, aluminum-alloy sheet up to about 0.65-in. thick, and low-carbon steel sheet up to 0.01 in. For high-production runs or heavier parts, the formblocks may be made of an aluminum-silicon alloy, or even steel.

b. The original process was obviously similar to the Guerin process, developed in the US before the war. The "modification" discussed in the present paper is apparently not very different from some of those used in the US.

c. Many of the advantages listed by Vasin and Malikov apply in the US as well. Here, however, the Guerin process is used mainly for aircraft production. It is quite doubtful that it would be chosen for production runs of automotive parts, such as the automobile headlights mentioned. It is generally considered in the US that a satisfactory surface may be retained in automobile headlights formed by more economic and faster methods.

15. P T Gorodnov: Salvage of Defective Gray-Iron Castings by Welding. Liteynoye Proizvodstvo (1952) no. 6, pp 2/3

a. Since the usual methods of repairing defective automobile and tractor castings by gas welding require an over-all preheat, tests were made to determine the feasibility of eliminating preheating by arc welding. Steel electrodes were satisfactory but the finished weld was not machinable. Monel metal and bronze (8% Sn) electrodes gave machinable deposits. The castings still would not meet hydraulic requirements after arc welding because of microcracks and pores in the transition zone and weld metal. Subsequent metallizing (aluminum, zinc or steel depending on application) remedied this failing so the castings could be made pressure tight.

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b. In the US and Great Britain, it is generally considered that there is no substitute for oxyacetylene torch welding with cast-iron rods and careful preheat with slow cooling where critical requirements are involved. Arc welding is seldom if ever recommended where pressure tightness is required. The "usual" method mentioned by Gorodnov seems to be much more in line with US and British practice than Gorodnov's method. Certainly it is difficult to see that Gorodnov's recommendation of arc welding and metallizing - even if perfectly satisfactory - would be any cheaper or simpler than preheating and gas welding.

G E Bellew: Salvage of Castings by Welding of Defects. TAFS 58 (1950) pp 669/674
Sub-Committee T.S. 23: Repair and Reclamation of Grey-iron Castings by Welding and Allied Methods. Foundry Trade Journal 89 (1950) pp 207/214, 216

c. In the US nickel electrodes are perhaps more commonly used than Monel electrodes for cast iron. Also, a copper-zinc brass electrode is probably more widely used than the tin bronze mentioned by Gorodnov. The fact that either Monel metal or bronze would be considered for such a relatively unimportant application where they were not absolutely necessary would tend to indicate no shortage of copper, nickel or tin.

16. M M Turbovskiy: Molten Inoculation. Liteynoye Proizvodstvo (1952) no. 6, pp 16/18

a. Numerous examples are given of the improved properties obtained with cast iron inoculated with an addition of molten, high-silicon gray iron. The advantages claimed for this type of inoculation over the more conventional means (as with solid ferrosilicon) are:

(1) temperature of iron being inoculated can be lower;

(2) amount of inoculant does not need to be as closely controlled;

(3) greater reliability and uniformity of results.

b. The improvement in properties shown by Turbovskiy would be expected with any properly inoculated gray iron. The supposed advantages of molten inoculation over conventional inoculation are not adequately documented nor are they very convincing. On the disadvantageous side is the fact that Turbovskiy's method would require at least two melting furnaces since one would be needed to supply the molten inoculant. Only in certain special cases is it possible that his process might have certain advantages; for example, if a foundry regularly producing malleable iron and a soft uninoculated gray iron wanted to make a limited amount of relatively high-strength gray iron but had no experience with conventional inoculation. Under such circumstances, Turbovskiy's method might be more foolproof than the usual inoculation.

17. B A Kaminskaya: High-Speed Reaming of Steel. Avtomobil'naya i traktornaya Promyshlennost' (1950) no. 12, pp 20/23

a. High-speed machining in the USSR has been limited mainly to milling cutters and similar tools with relatively little attention paid to tools such as drills and reamers. The limited work that has been done on the latter types of tools has been largely confined to cast iron. The present paper deals with the development of reamers tipped with sintered carbide that are suitable for machining steel. Further development in connection with the commercial production of these drills will continue.

b. In the US also, less attention has been paid to high-speed drilling and reaming than to other forms of machining; although solid twist drills of sintered carbide as well as tipped reamers and drills are being used on various types of metals including steel.

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c. The tests were made on bevel gears of grade 18KhGT, which does not correspond to any of the standard US grades. The nearest equivalent would be AISI-SAE 5120, which has somewhat lower manganese (0.70/0.90% vs 0.8/1.1) and significantly lower chromium (0.70/0.90% vs 1.0/1.3). Moreover, the Soviet steel contains 0.08/0.15% Ti. (The 0.8 figure in the text is obviously a typographical error for 0.08.)

(1) Without titanium this grade would give a high carbon concentration in the case unless special precautions were taken during carburizing (mild carburizing media, diffusion treatment). Such excess carbides may be advantageous in some applications involving wear, but are generally considered undesirable in the US because of the poor toughness and grindability of high-carbon cases.

(2) The general subject of the Soviet use of titanium in carburizing steels has been previously discussed. There is no indication that titanium would minimize a carbon build-up in the case.

> M P Braun and P E Voronov: High Strength Low Alloy Carburizing Steels. Stal 6 (1946) pp 181/188

> A N Minkevich: Chemico-Thermal Treatment of Steel. Gosudarstvennoe Nauchno-Tekhnicheskoe Izdatel'stvo Mashinostroitel'noi Literatury. Moscow (1950). 432 pp

(3) With the emphasis on high-speed machining, it is rather surprising that no attention was given to the optimum microstructure of the steel being machined, or to the possibilities of using a free-machining type of alloy steel.

18. K P Bunin, N M Danil'chenko and G I Ivantsov: The Origin of Stringers of Graphite Inclusions in Malleable Iron. Liteynoye Proizvodstvo (1952) no. 6, pp 21/23

a. A routine investigation. (Blackheart) malleable iron sometimes shows graphite stringers after annealing, which have a deleterious effect on properties and particularly on toughness. This defect is caused by shrinkage pores, which form between the dendrite arms during the final stages of solidification. Graphite stringers can therefore be avoided by improving casting and feeding practices.

b. Although it is stated that no information could be found in the literature on this type of defect, it appears to be similar to one discussed by Laplanche and attributed to the same cause. Otherwise the present paper represents an adequate, unimaginative investigation.

> H Laplanche: Les Principales maladies de la malleable a coeur noir et leur diagnostic micrographique. Fonderie (1947) no. 14, pp 507/526; no. 15, pp 564/581

19. S G Zbarskiy: Production of High-Quality Cupola Iron. Liteynoye Proizvodstvo (1952) no. 6, pp 28/29

a. Another scheme to avoid conventional inoculation. The cupola is charged so it melts alternate layers of a low-carbon, low-silicon iron, and a high-carbon, high-silicon iron. When these are tapped in proper proportion and sequence, the resultant iron has the improved properties that would be expected from inoculated iron.

b. Unlike Turbovskiy's proposal in this same issue, Zbarskiy's idea requires only a single furnace, but is more complicated and probably would be less reliable. Certainly Zbarskiy's method would be much more difficult to carry out in practice than a conventional inoculation. The obvious desire of both men to avoid a conventional inoculation is rather strange, since it is a relatively simple operation with, for example, a small ladle addition of ferrosilicon.

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c. The hardnesses reported are about what would be expected with an inoculated iron of the carbon and silicon contents given. Usually such low-silicon irons with about 3% C are not cupola melted in the US ; either an electric furnace or a duplex process would be used. With cupola iron, however, it would appear to be much simpler and easier to melt to a slightly higher carbon content, and then make a small alloying addition in the ladle to bring the hardness and strength up to the desired values rather than to bother with such complicated procedures as foreseen by Zberskiy.

20. I I Goryunov: Annealing Malleable Iron in Liquid Media. Liteynoye Proizvodstvo (1952) no. 6, pp 18/21

a. An interesting paper. An extremely rapid annealing treatment for (blackheart) malleable iron has been developed in the USSR. The main feature of this method is the use of a molten salt bath (barium chloride) for first-stage graphitization; under these conditions, only 30 minutes are required as opposed to a minimum of several hours when the malleable iron is heated in a furnace.

(1) The heating rate is naturally much more rapid in a salt bath than in a conventional atmosphere furnace or in a sand-packed box.

(2) Even with the same holding time after reaching 1830°F, iron heated in a salt bath graphitizes more rapidly than iron heated in an atmosphere furnace or in a box.

(3) At the eutectic temperature, the decomposition of combined carbon is practically instantaneous.

(4) Preliminary quenching also accelerates first-stage graphitization.

(5) On the other hand, heating in a salt bath has no affect on the time required for second-stage graphitization.

(6) Plant tests showed pearlitic or pearlitic-ferritic malleable iron had a finer and more uniform structure if the first-stage graphitization had been carri[illegible] in a salt bath. Subsequent service tests on bearings gave satisfactory results for malleable-iron parts treated by the new method.

(7) Annealing in salt baths at temperatures near the eutectic temperature gives flake graphite rather than the usual nodular temper carbon.

b. As far as is known, salt baths are not used in the US for annealing malleable iron. Furthermore, the temperatures used for first-stage graphitization are considerably lower here (about 1550/1725°F). Various steps have been taken in the US , however, to shorten the annealing cycle of malleable iron. Continuous furnaces with atmospheric control have been introduced to eliminate the necessity for pots and packing and thus to accelerate the rate of heating and cooling. "Short-cycle malleable" with relatively low carbon and high silicon is used in some cases to give iron that will graphitize more readily; small additions of elements such as bismuth and boron may also be added to permit the use of such high silicon contents without having the iron gray as cast. Even with short-cycle malleable, however, about ten hours at 1725°F are still allowed for first-stage graphitization. This type of malleable iron generally has about 1.4/2.0% Si, whereas the highest silicon content in any of the irons investigated by Goryunov was 1.51%. Therefore the results obtained by Goryunov cannot be attributed to composition alone (the comparative tests with furnace heating indicate that trace elements are probably not involved).

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c. The claim that graphitization is practically instantaneous may be viewed with some skepticism, although Massari has confirmed that the time required for first-stage graphitization decreases as the temperature increases. With a "low total carbon malleable iron" somewhat similar to those tested by Goryunov, the time required decreased from over 300 minutes at 1700°F to about 6 minutes at 2000°F.

S C Massari: Graphitizing Behavior of White Iron. TAFS 57 (1949) pp 226/232; disc 231/232

d. Shortening the graphitizing cycle would be advantageous only if it does not have an adverse effect on properties. The presence of flake rather than nodular graphite would undoutedly impair the good machinability that is one of the outstanding advantages of malleable iron. Moreover, the discussion of Massari's paper indicated that high-temperature graphitization had a deleterious effect on mechanical properties. Goryunov does not give comparative data on the mechanical properties of his quick-annealed iron and malleable iron given an ordinary anneal. A rough comparison of the information he does give with that published elsewhere tends to indicate considerably lower ductility and toughness for the quick-annealed iron than would normally be expected in malleable iron. This of course would be quite natural if the graphite is in flake form rather than nodular. It is possible that a compromise might be struck that would give adequate properties with a shorter-than-normal graphitizing treatment.

American Malleable Iron. Malleable Founders' Society (1944)
H Laplanche: Les principales maladies de la malleable a coeur noir et leur diagnostic micrographique. Fonderie no. 14 (1947) pp 507/526; no. 15, pp 564/581

21. V I Mel'nik: Use of Arc Welding in Construction. Avtogennoye Delo (1950) no. 11, pp 23/26

a. A routine article. Of interest, however, is a list of six "deficiencies" that are hindering the use of arc welding in construction and impeding progress:

(1) Designers still are not wholly convinced of the virtues of welding.

(2) Although many good electrodes are being produced, there is still not a satisfactory all-position electrode for high-production welding (E42A).

(3) Many plants producing electrodes have difficulty in obtaining the necessary coating ingredients.

(4) Since many constructors wish to weld in winter, reliable portable equipment for induction preheating is needed. Methods of welding with local preheating should be worked out.

(5) Constructors need direct-current machines with 500/600 amp capacity and diesel engines, portable transformers with 750 amp capacity, and semiautomatic submerged-arc welding apparatus.

(6) It is necessary to organize the production of welding helmets and electrode holders. Also, welders should be provided with protective clothing of leather or substitute material as canvas is not safe.

b. Mel'nik seems to feel that the desires of the construction industry are not given enough consideration by the welding industry in general. Of his complaints, the main one that might be considered to apply to some extent in the US also is Al.

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22. Ye V Sokolov: Electrodes with Quality Coatings and Their Production. Avtogennoye Delo (1950) no. 11, pp 26/29

a. More or less of a review of some of the development work being done at the Experimental Welding Plant TsNII MPS.

(1) Most of the article is devoted to coatings: factors affecting viscosity; addition of ferromanganese and other deoxidizers; grain size, drying.

X (2) The last part deals with specific electrodes. Among other things discussed:

(a) Fisheyes in weld deposits should not be considered as cause for rejection of the electrodes as they can be overcome by proper aging of the electrodes before use.

(b) New hard-surfacing alloys, which are in great demand, are mentioned. Compositions are given of three that have been introduced for applications requiring high hardness:

	hardness	%C	%Cr	%B	%Ti
T-590	Rc 58/62	3/3.5	22/27	about 1.5	...
T-620	Rc 55/60	3/3.5	20/23	about 1.5	1.1/1.5
T-540	Rc 24/27*) Rc 34/45**) Rc 56/60***)	1.2/1.5	7.5/9.5	...	1.0/1.3

* as annealed
** as deposited
*** as quenched and tempered

(c) Some commercial stainless-steel electrodes have given deposits with low elongation and strength, and with pronounced susceptibility to hot cracking. No connection could be found between these defects and chemical composition of the wire or coating. Welding conditions were also not a factor. The defective deposits were obtained with all grades except TsL-4, which has molybdenum in the coating. Investigations showed that high properties and flawless deposits could be obtained if 5% Mo (or the corresponding 10% ferromolybdenum) were added to the coating of the 18-8 electrode, and 10% Mo to the coating of the 25-20 electrode.

b. With ordinary mild-steel electrodes, fisheyes and fissures are frequently observed in as-welded tensile specimens. These defects, resulting from hydrogen in the weld metal, are removed by stress relieving. (Of course, another method of avoiding such defects is the use of electrodes with low-hydrogen coatings, which are not mentioned.) Sokolov recommends aging for 20/25 days at room temperature, X or 8/10 hr in boiling water, or 2/3 hr at 390/480°F. It is doubtful that either of the first two alternatives would remove much hydrogen, especially if the atmosphere were moist.

X US requirements are obviously more severe than those about which Sokolov is complaining, since ASTM A 233-48T for Mild Steel Arc-Welding Electrodes of the type under question includes a requirement for maximum hydrogen content of the weld deposits.

c. The three hard-surfacing compositions are similar in type to some of those being X produced in the US , although boron and, especially, titanium are not widely used in electrodes of this type.

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d. From the brief description of the difficulty with the stainless-steel electrodes it is believed that the trouble probably stems from the structure of the weld deposit. It has generally been observed in the US and elsewhere that such cracks are always more prevalent in fully austenitic than in partially ferritic deposits. Molybdenum appears to overcome tendencies toward cracking not only by forming ferrite in the weld metal but also by strengthening the austenite. Not enough information is given for calculation of the percentage of ferrite, but 5% Mo in an 18-8 deposit, or 10% in a 25-20 deposit, would undoubtedly give a relatively large amount of ferrite. In this country satisfactory results are obtained with lesser amounts of molybdenum. (It is also possible to make other modifications in composition to obtain the 3 to 5% ferrite generally considered desirable.) Certainly such large additions do not indicate any shortage of molybdenum.

G Riedrich: Neuere Entwicklungen auf dem Gebiete der rost- und säurebeständigen Stähle. Metallwirtschaft 21 ([illegible]) pp 407/411

K L Zeyen and W Lohmann: Schweissen der Eisenwerkstoffe, 2. edition, Düsseldorf (1948)

R D Thomas, Jr: Crack Sensitivity of Chromium-Nickel Stainless Weld Metal. Metal Progress 50 (1946) pp 474/479

e. It is interesting that Sokolov mentions the fact that despite its growth and successes, there are some unsatisfactory phases of the welding-electrode industry in the USSR both in regard to quantity and quality.

end

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